

# ***HQ U.S. Air Force Academy***

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## **Comparison of the 1.5 Mile Run Times at 7,200 Feet and Simulated 850 Feet in a Hyperoxic Room**



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## Report Documentation Page

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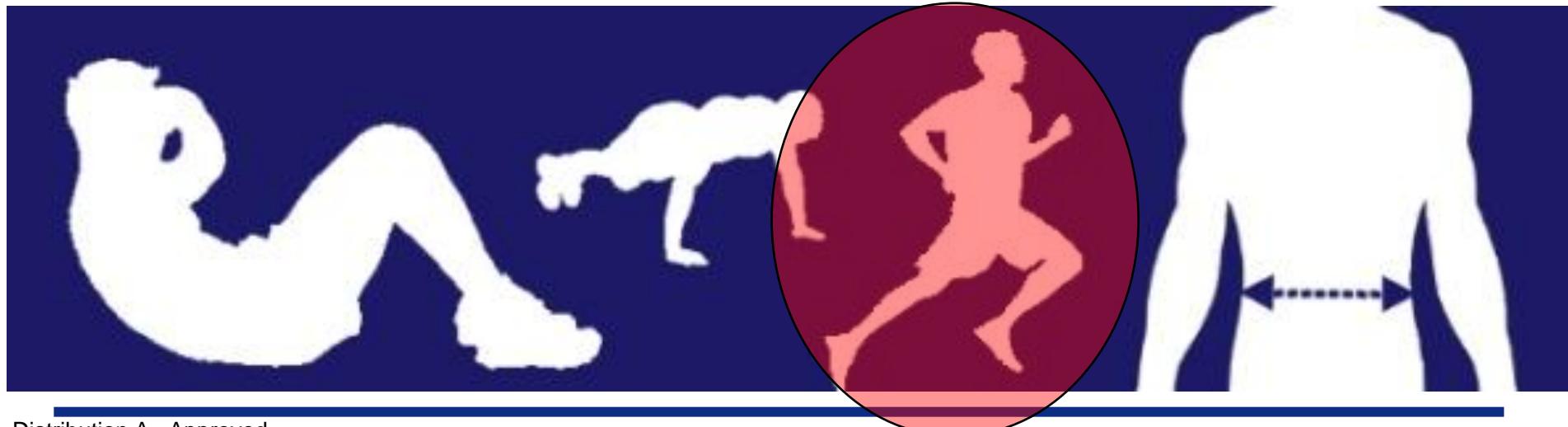
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# Study Objective

This study investigated if there are differences in **aerobic** performance between altitude and simulated sea level environments and if differences are evident between conditions, to what extent?





# Background Information

- **1968** - Dr. Ken Cooper develops the 12 minute run fitness test as an easy, inexpensive and relatively accurate way to estimate  $\text{VO}_2$  max, or aerobic fitness, in large groups of Air Force personnel. ( $R = .897$ )
  - Based on results of 115 airmen
  - Better indicator of cardiovascular fitness than the 600 yard run.
- Later Dr. Cooper developed the 1.5 mile test
- **1992** - Cycle ergometry test was implemented to “predict”  $\text{VO}_2$  max.





# Background Information (cont)

- **2004** - New Air Force fitness program was implemented that once again used the 1.5 mile test.
- **2005** - An altitude adjustment was implemented for airmen stationed above 5,000 ft. (1.75 pts)
- **2010** - New Air Force fitness test program was implemented, which still used the 1.5 mile run to test aerobic fitness, but the altitude adjustment for the Air Force Bases located at moderate altitude is removed.





# Background Information (cont)

“The high altitude calculation was removed as all individuals are already given a temporary exemption of six weeks to adapt to the altitude differences between locations”

and

“With six weeks to acclimatize and continue training at altitude, members' 1.5 mile run performance should not be appreciably degraded”

and

“Exercise research indicates that a score adjustment for people taking the revised Air Force Physical Fitness Test at higher altitudes is not needed. The VO<sub>2</sub> max or aerobic fitness, the factor we are measuring with the 1.5 mile run, is not measurably altered in a non-acclimated member testing from sea level up to 7,000 feet.”

(Air Force Fitness Program Web Site FAQ)



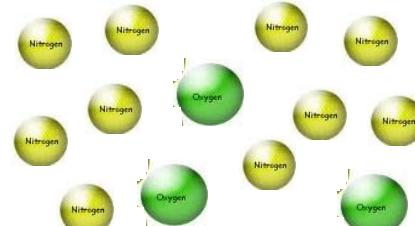
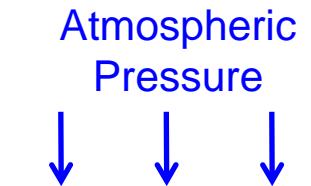
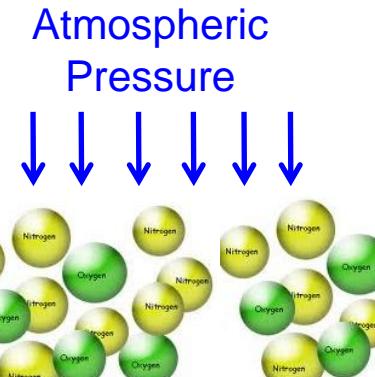


# Background Information (cont)

- As altitude is increased, barometric pressure decreases
  - Results in less oxygen per given volume of air than at sea level
  - Known as **hypobaric hypoxia**
- Current research shows that total acclimatization can take up to 4-6+ months (Brothers, 2008; Brothers, 2007)
- Aerobic endurance still is impaired even with total acclimatization (Brothers, 2008; Brothers, 2007)
- Training intensities are reduced at altitude which results in deconditioning of the body (TB 505, 2010)
- To date, it is unknown the exact amount of decrement associated with various levels of the hypobaric hypoxic environments.

Oxygen content at Sea Level (20.9%)

Oxygen content at Altitude (20.9%)



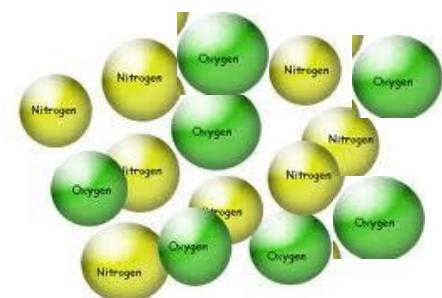


# Protocol

- Time requirement for each subject was ~2 hours
  - 30 min- ICD and  $VO_{2\max}$  introduction
  - 30 min-  $VO_{2\max}$  and DXA scan
  - 30 min- 1.5 mile run in first condition
  - 30 min- 1.5 mile run in opposite condition
- All 1.5 mile runs were performed in the Colorado Altitude Tent (CAT) in normal moderate altitude environment (~7,200 ft) or **normobaric hyperoxic environment** (oxygen content increased while barometric pressure stayed the same) to simulate ~850 ft.
- Order of running conditions were randomized.
- Only 24 to 72 hours between 1.5 mile runs
- Distance was the only factor known by the subjects during the 1.5 mile runs



Oxygen Content in  
CAT (~26.5%)





# Creating a Hyperoxic Environment

Partial Pressure of O<sub>2</sub>

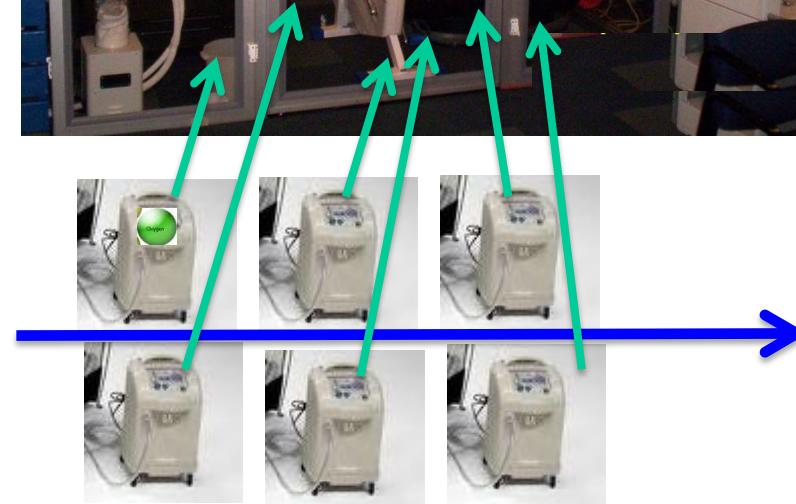
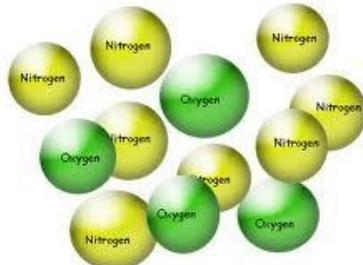
SL

.21 \* 760 mmHg = PO<sub>2</sub> of **160 mmHg**

**7,200 FT**

.21 \* 570 mmHg = PO<sub>2</sub> of **120 mmHg**

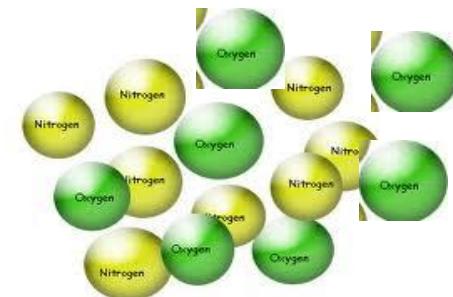
Oxygen content at Altitude (20.9%)



CAT

265 \* 570 mmHg = PO<sub>2</sub> of **152 mmHg**

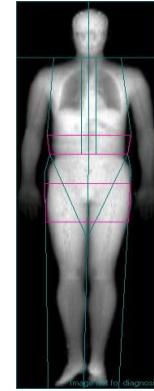
Oxygen content in CAT (~26.5%)





# Dual Energy X-Ray Absorptiometry (DXA) Scanner for Body Composition

- **“Gold Standard” for body composition**
- Assessments provide :
  - % fat mass
  - % lean body mass
  - Bone density



REGION	TOTAL	Left	Right
Arms	14.2%	14.3%	14.1%
Legs	23.1%	23.9%	23.1%
Trunk	25.3%	25.3%	25.3%
Total	22.3%	22.2%	22.40%

**% Body Fat**





# VO<sub>2</sub> Max test

- All VO<sub>2</sub> max tests were performed at altitude
- Subjects were asked to continue running until they reached volitional fatigue
- Protocol

Test Time (min)	Stage Time (min)	Speed (mph)	Grade (%)	Position
0-1	1:00	0	0	Standing
2-3	2:00	2.0	0	Walking
4-5	2:00	7.0 m, 6.0 f	0	Running
6	1:00	7.0 m, 6.0 f	2	Running
7	1:00	7.0 m, 6.0 f	4	Running
8	1:00	7.0 m, 6.0 f	6	Running
9	1:00	7.0 m, 6.0 f	8	Running
10	1:00	7.0 m, 6.0 f	10	Running
11	1:00	7.0 m, 6.0 f	11	Running
12	1:00	7.0 m, 6.0 f	12	Running
13	1:00	7.0 m, 6.0 f	13	Running
14	1:00	7.0 m, 6.0 f	14	Running
End of Test	Until HR <120	2.0	0	Active Recovery



# Max VO<sub>2</sub>





# Study Participants

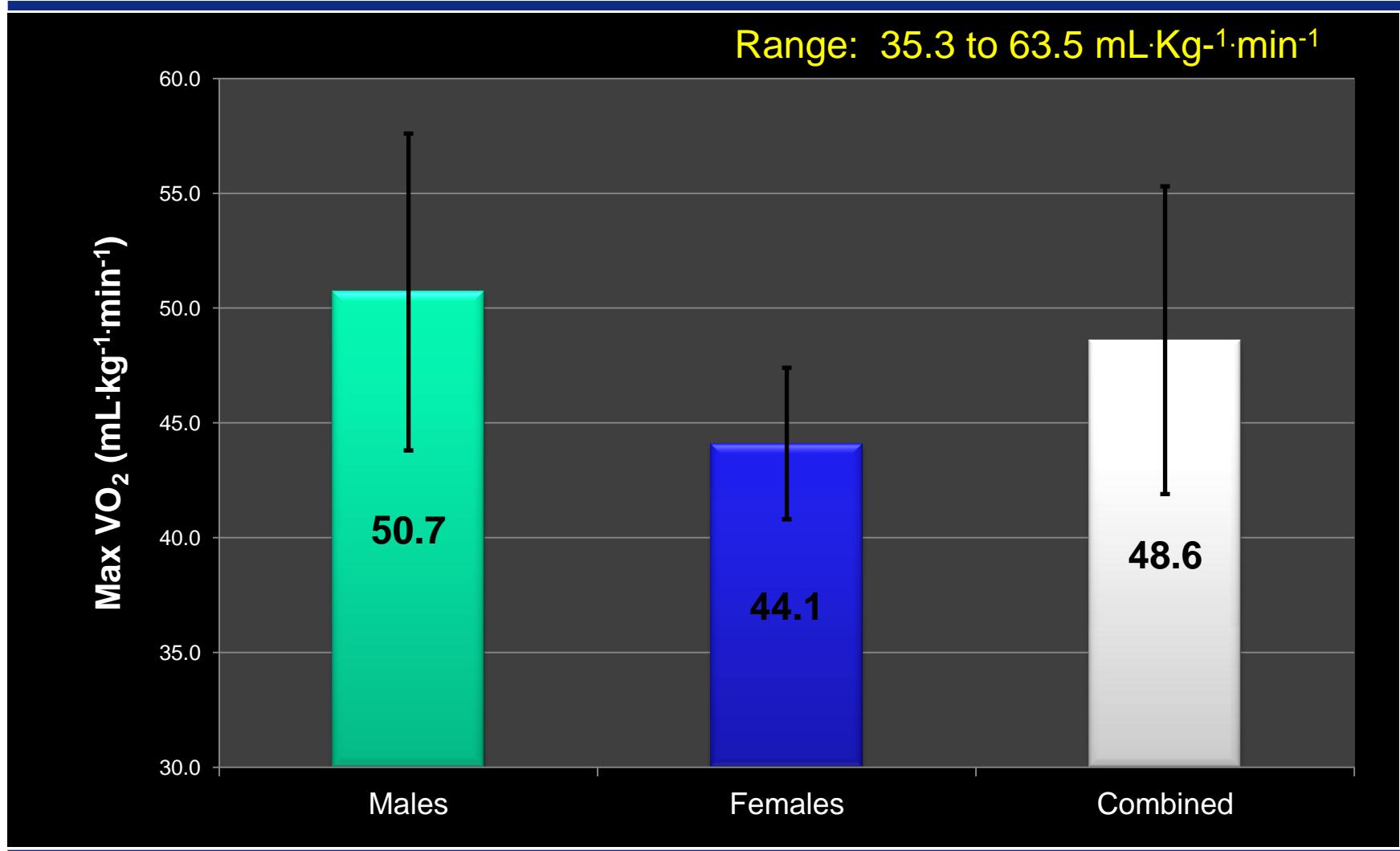
- Fifty-five, non smoking, male and female subjects signed informed consent documents (ICD) and completed DXA and  $VO_{2\text{max}}$  tests
- All subjects had to be living continuously in Colorado Springs for at least 6 weeks.
- Three subjects did not complete the 1.5 miles run tests due to AF commitments and non-study related injuries
- *Subjects demographics:*



	n	DXA (%BF)	Age (yrs)	Weight (lbs)	Height (in)
Males	38	$16.4 \pm 7.6$	$32.3 \pm 6.5$	$173 \pm 24$	$71.7 \pm 3.1$
Females	17	$24.9 \pm 4.7$	$33.6 \pm 6.9$	$132 \pm 18$	$64.7 \pm 2.2$
Total	55	$19.0 \pm 7.9$	$32.7 \pm 6.6$	$160 \pm 29$	$69.5 \pm 4.4$



# Subjects Demographics (cont): VO<sub>2</sub> Max



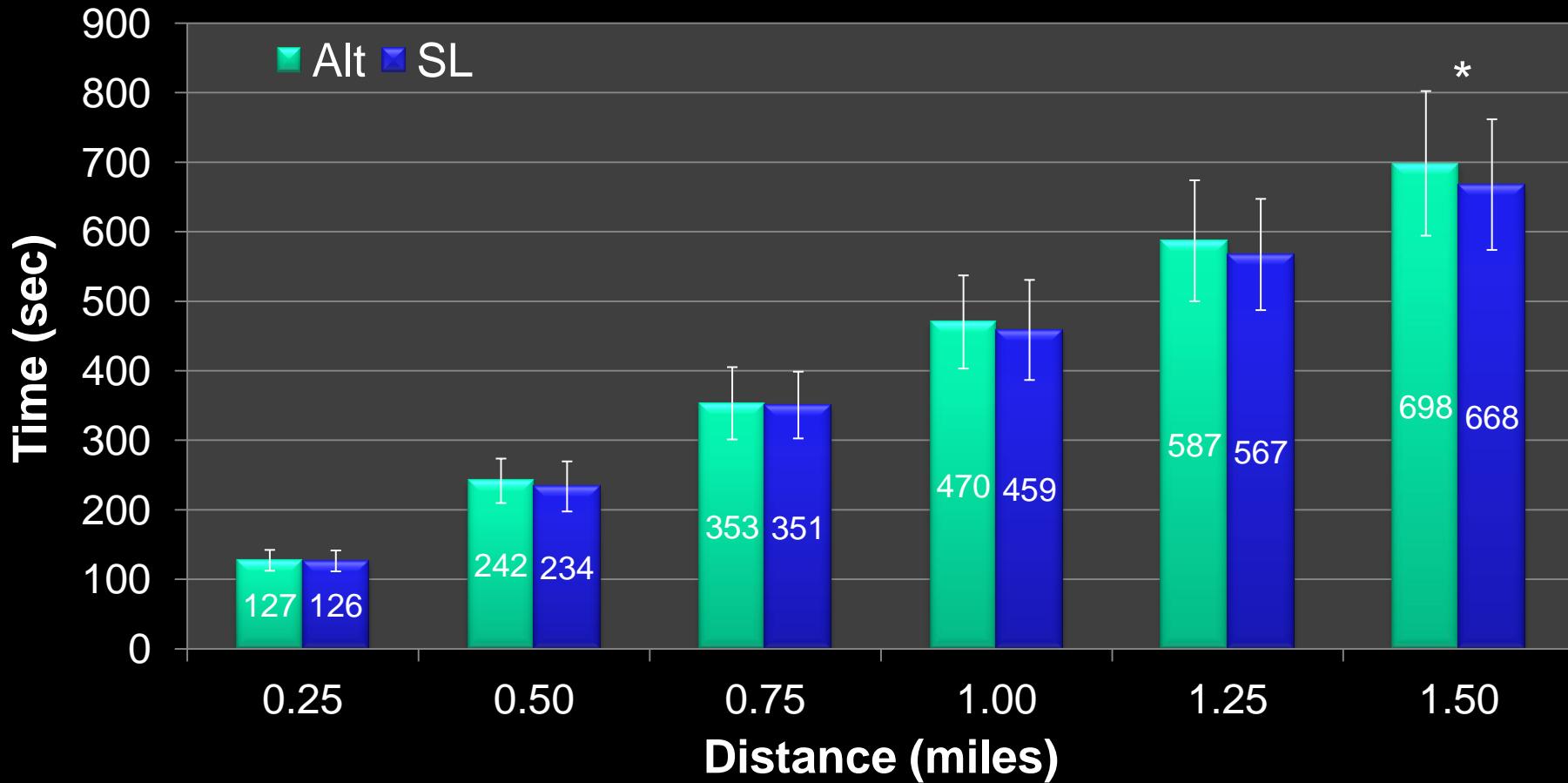


# Results





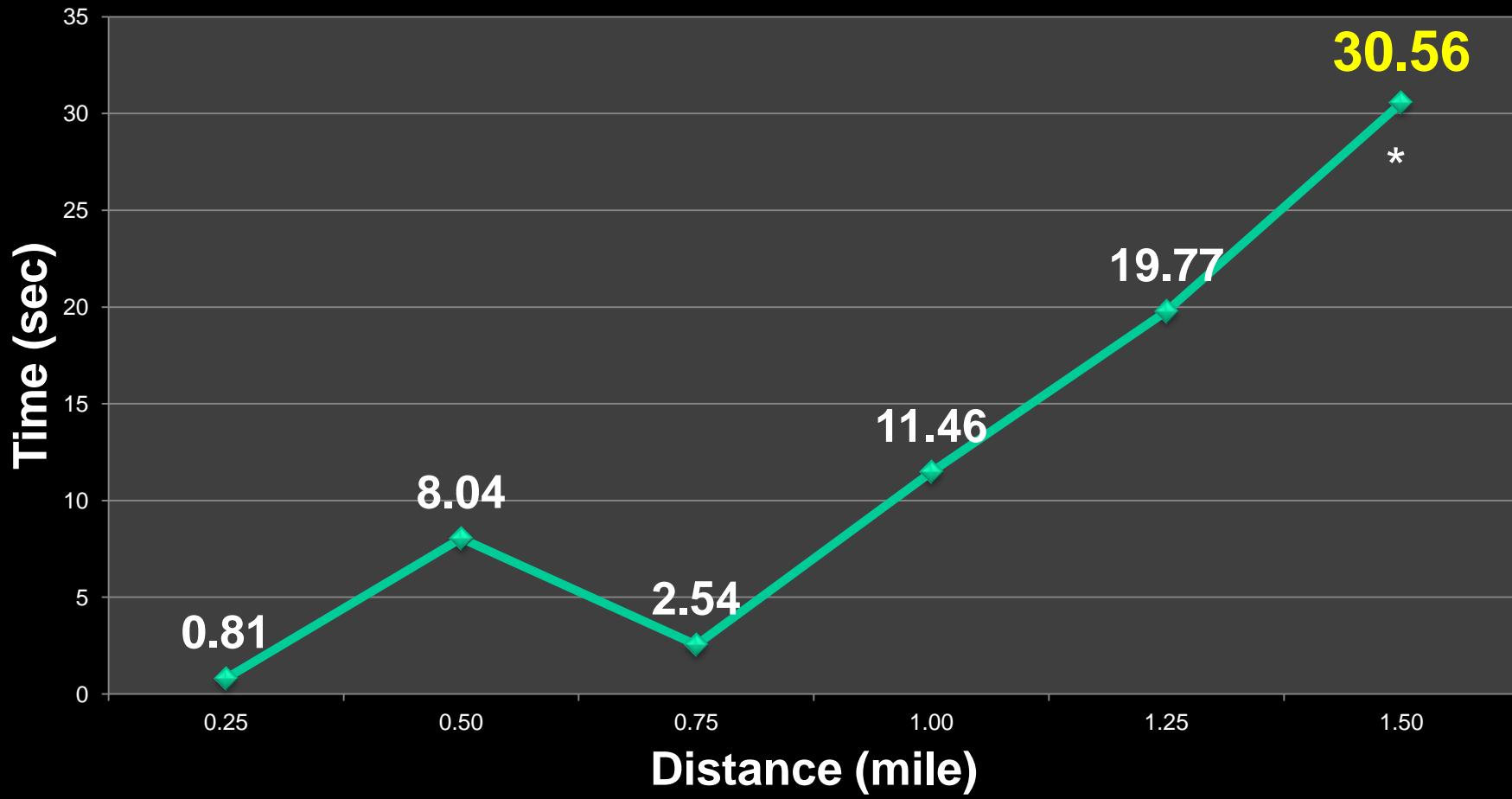
# 1.5 Mile Run times at ALT and SL



\* p<0.001



# Differences between ALT and SL run times



\* p<0.001



# Rate of Perceived Exertion during 1.5 Mile Runs at ALT and SL



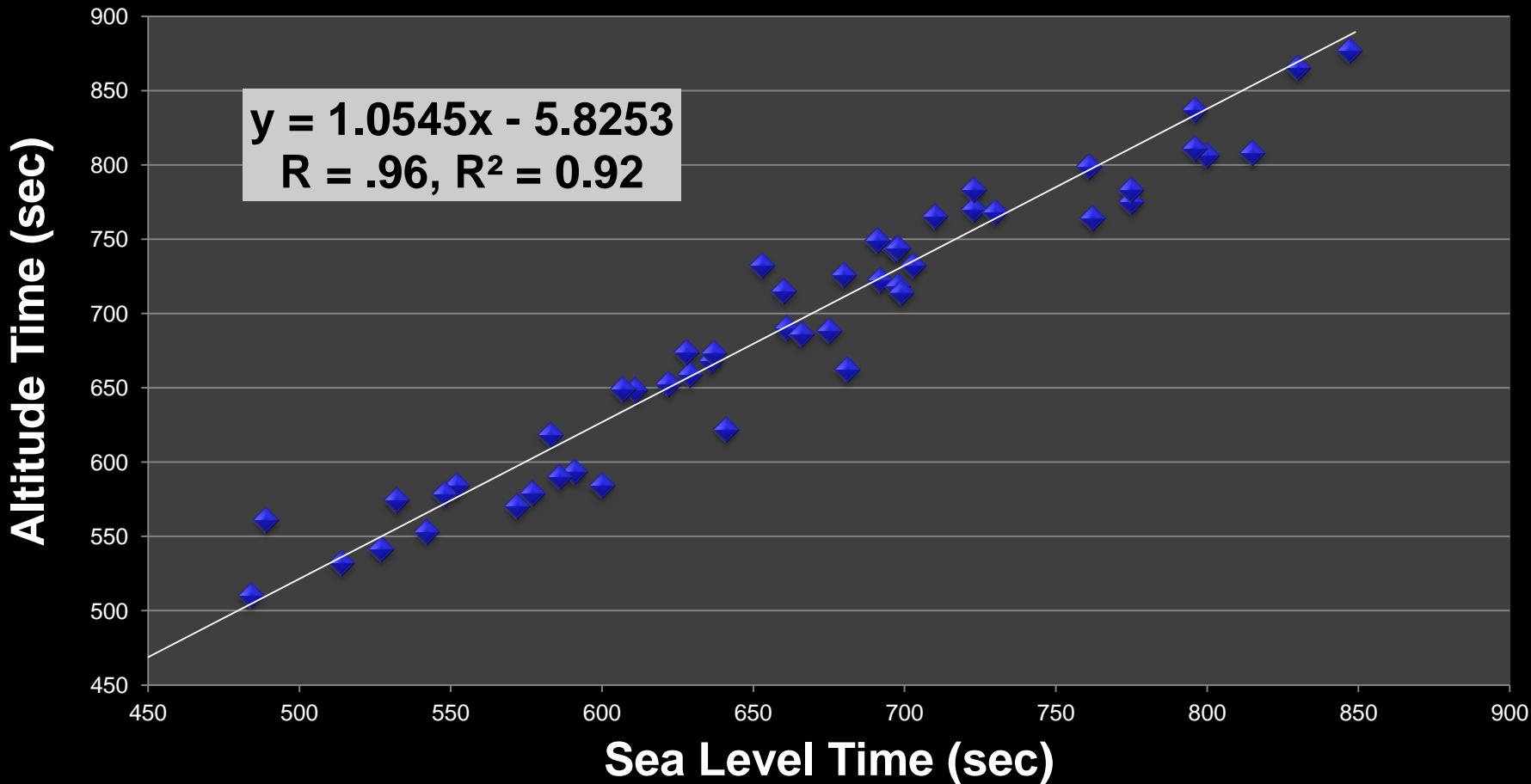


# Differences seen with Randomization of 1.5 Mile Runs



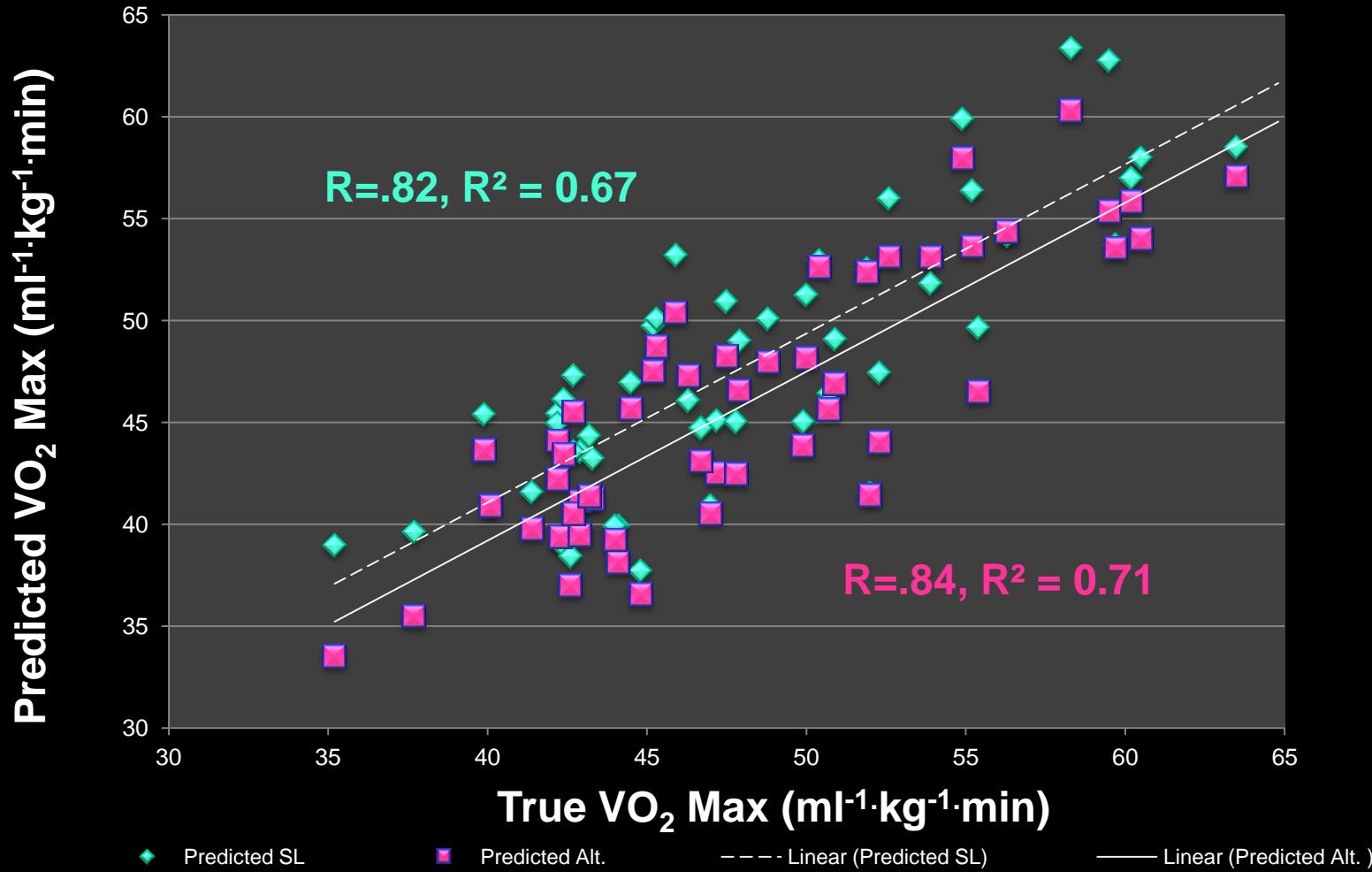


# Comparison of run times at ALT and SL



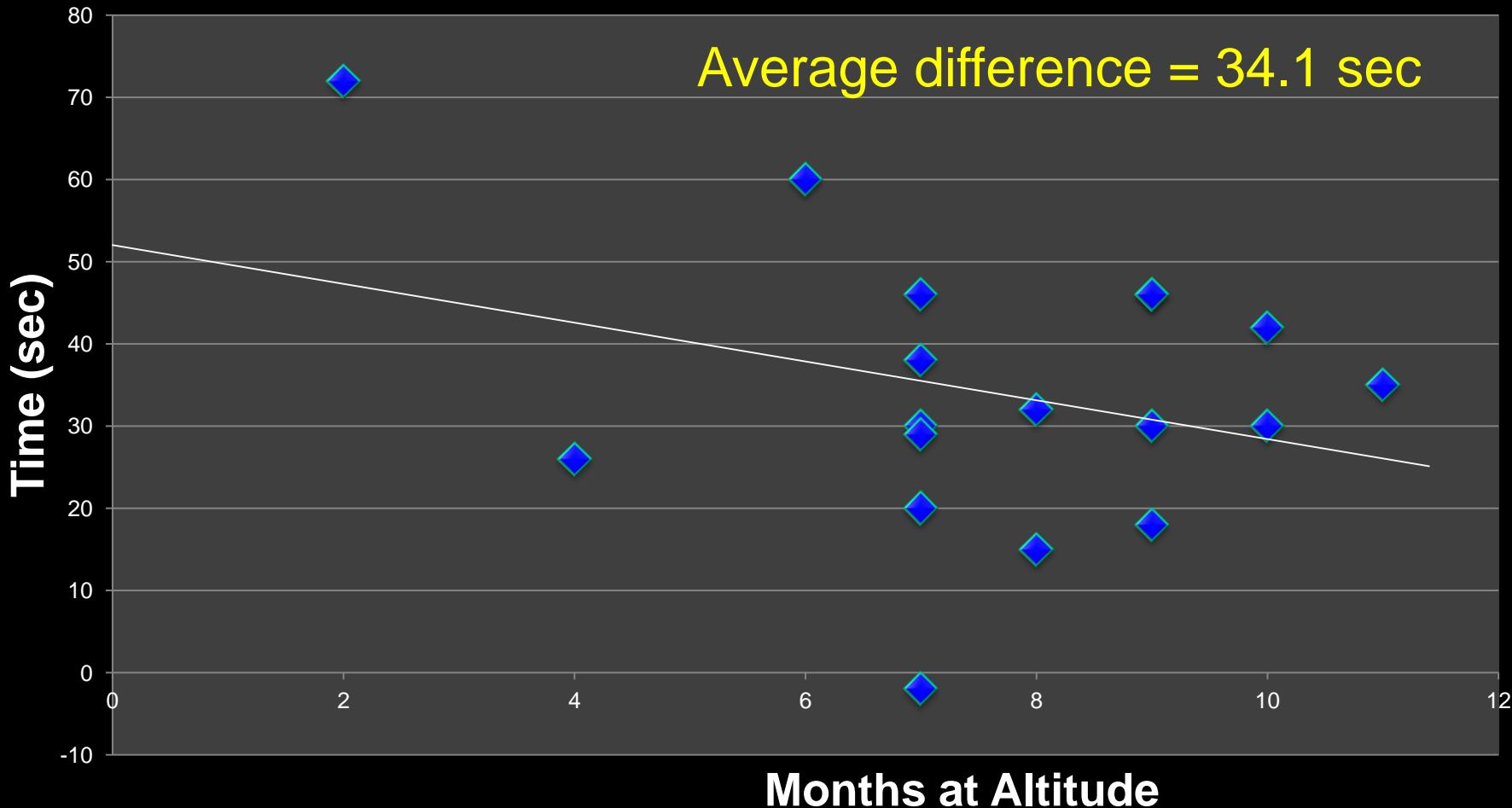


# VO<sub>2</sub> Max vs. Predicted VO<sub>2</sub> at 850 and 7,200 Feet





# Time Differences for Subjects (18) Living at Moderate Altitude <1 year



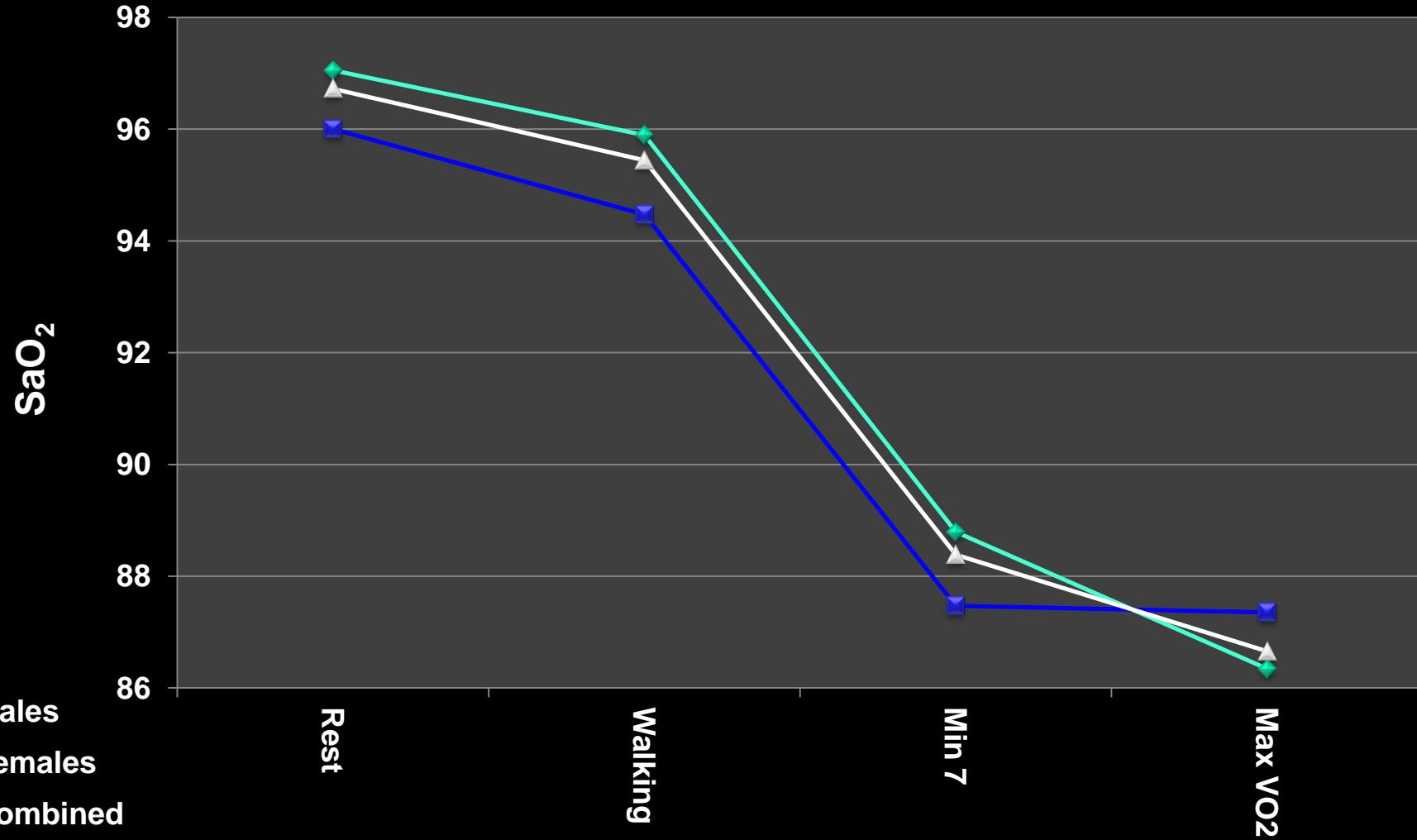


# Heart Rates during 1.5 mile runs at ALT and SL



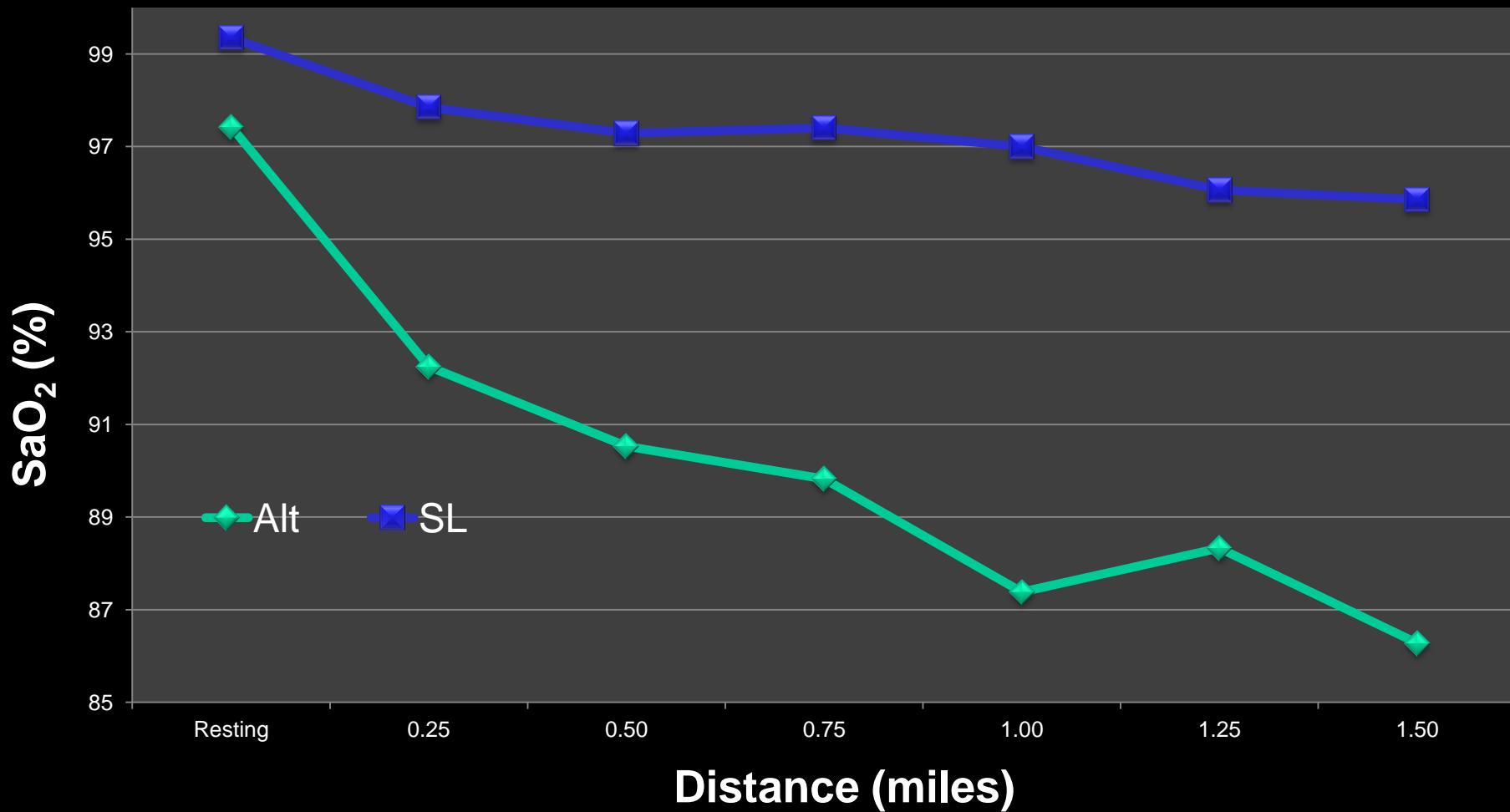


# SaO<sub>2</sub> levels during the Max VO<sub>2</sub> test





# Average SaO<sub>2</sub> During 1.5 Mile Runs





# Conclusions

- A 30.6 seconds, or 4.2% decrease in 1.5 mile running times was measured when running at ~850 ft compared to 7,200 ft.
- These differences were mainly due to a decreased hemoglobin oxygen saturation associated with running at altitude with lower O<sub>2</sub> partial pressures.
- HR and RPE were not significantly different between runs
- Our recommendation is that an altitude adjustment for the Air Force fitness test be reinstated for airmen testing at moderate altitude bases.





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